

# FIRST MESOZOIC MAMMAL FROM CHILE: THE SOUTHERNMOST RECORD OF A LATE CRETACEOUS GONDWANATHERIAN

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## ABSTRACT

We describe *Magallanodon baikashkenke* gen. et. sp. nov., a new gondwanatherian mammal from the Late Cretaceous of the Magallanes Region in southern Chile (Río de Las Chinas Valley, Estancia Cerro Guido, north of Puerto Natales city, Última Esperanza Province). The mammal-bearing layer is placed within the Late Campanian-Early Maastrichtian levels of the Dorotea Formation (Magallanes/Austral Basin). The new remains constitute the southernmost record of a Mesozoic gondwanatherian mammal, as well as the first Mesozoic mammal from Chile. This taxon is comparable in size to the hypsodont-toothed *Gondwanatherium* (Late Cretaceous) and *Sudamerica* (Early Paleocene) but with noticeably brachyodont molariforms supported by four to five roots. As in other gondwanatherians, it has at least one hypertrophied, rodent-like incisor in the upper jaw. The new taxon is here diagnosed and described, and is regarded as a possible ferugliotheriid (?Ferugliotheriidae). If confirmed, it would represent the largest known taxon for this family. Its molariform occlusal crown pattern, after wear, resembles that of other gondwanatherians, particularly ferugliotheriids and that of the sudamericid *Gondwanatherium*. This adds new evidence on the phylogenetic proximity of ferugliotheriid and sudamericid gondwanatherians. An analysis of the enamel microstructure of the upper incisor of *Magallanodon* was performed demonstrating several crucial similarities with the pattern shown by *Gondwanatherium* (Sudamericidae). We discuss the significance of *Magallanodon* for understanding the acquisition, within gondwanatherians, of a lophed molariform pattern. Finally, we discuss the significance of the new finding in the context of southern biotas, including those of Patagonia and Antarctica.

**Keywords:** Gondwanatheria, Mammalia, Molariforms, Campanian-Maastrichtian, Dorotea Formation, Magallanes/Austral Basin, Chile.

## RESUMEN

**Primer mamífero Mesozoico de Chile: el registro más austral de un gondwanaterio del Cretácico tardío.** Se describe a *Magallanodon baikashkenke* gen. et. sp. nov., un nuevo mamífero gondwanaterio del Cretácico tardío de la Región de Magallanes, en el sur de Chile (Valle del Río de Las Chinas, Estancia Cerro Guido, norte de Puerto Natales, Provincia de Última Esperanza). Las capas portadoras se ubican entre los niveles del Campaniano tardío-Maastrichtiano temprano de la Formación Dorotea (Cuenca de Magallanes/Austral). Los nuevos restos constituyen el registro más austral de un mamífero gondwanaterio del Mesozoico, como así también el primer mamífero Mesozoico conocido para Chile. El nuevo taxón es comparable en tamaño a las formas hipsodontes *Gondwanatherium* (Cretácico tardío) y *Sudamerica* (Paleoceno temprano), pero con molares notoriamente braquidontes soportados por cuatro a cinco raíces. Como en otros gondwanaterios, posee al menos un incisivo superior rodentiforme en la serie superior. Se diagnostica y describe brevemente el nuevo taxón, considerado tentativamente como un feruglioteriido (Ferugliotheriidae). De confirmarse esta asignación, este nuevo taxón representaría el miembro de mayor tamaño para la familia. El patrón oclusal de los molariformes, con el desgaste, se semeja también al de otros gondwanaterios, en particular al de los feruglioteriidos y al del sudamerícido *Gondwanatherium*, agregando en consecuencia más evidencias en favor de la proximidad filogenética entre ambas familias. Se llevó a cabo un análisis de la microestructura del esmalte del incisivo superior de *Magallanodon*; como resultado, se encontraron varias similitudes importantes con el patrón existente en *Gondwanatherium* (Sudamericiidae). Se discute la significación de *Magallanodon* en la adquisición, entre los gondwanaterios, de un patrón molariforme caracterizado por la presencia de lofos transversos. Finalmente, se discute la significación del nuevo hallazgo en el contexto de las biotas australes, incluyendo aquellas de Patagonia y Antártica.

**Palabras clave:** Gondwanatheria, Mammalia, Molariformes, Campaniano-Maastrichtiano, Formación Dorotea, Cuenca de Magallanes/Austral, Chile.

## INTRODUCTION

Even though South America has an impressive fossil record of Cretaceous terrestrial vertebrates (e.g., Bonaparte 1996, Martinelli and Forasiepi 2004, Novas 2009, Bittencourt and Langer 2011, Rubilar-Rogers *et al.* 2015), mammals are still sparse components of these assemblages. Their remains are known from few localities in the Argentinian Patagonia (e.g., Bonaparte 1986a, 1987, 1990, Pascual *et al.* 2000, Rougier *et al.* 2009a, b, 2011a, b, Forasiepi *et al.* 2012), as well as from isolated and extremely fragmentary records in Bolivia, Brazil, and Peru (Mourier *et al.* 1986, Bertini *et al.* 1993, Gayet *et al.* 2001, Castro *et al.* 2018). With the exception of two cladotherian mammals, *Vincelestes neuquenianus* (Early Cretaceous; Bonaparte 1986a) and *Cronopio dentiacutus* (earliest Late Cretaceous; Rougier *et al.* 2011b), most taxa are based on isolated teeth and partial upper or lower jaws (Bonaparte 1986a, b, 1990, 1994, 2002, Pascual *et al.* 2000, Chornogubsky 2011, Rougier *et al.* 2009a, b, 2011a).

For the Late Cretaceous, the peak of mammalian diversity is plainly represented by non-therian species counting a dozen dryolestoids, including Laurasian-related dryolestids and South American endemic, bunodont meridiolestids (Bonaparte 1986a,b, 1990, 2002, Rougier *et al.* 2009a, b, 2011a), a few and poorly known taxa of Gondwanatheria, including sudamericids and ferugliotheriids (Bonaparte 1986a, b, Mones 1987, Krause *et al.* 1992, Krause and Bonaparte 1993, Pascual and Ortiz-Jaureguizar 2007, Gurovich and Beck 2009), and probable cimolodontan multituberculates (Kielan-Jaworowska *et al.* 2007).

The Order Gondwanatheria was recognized by Mones (1987) for the inclusion of two enigmatic mammals described few years before: the first one was *Sudamerica ameghinoi* from the Paleocene of the “Banco Negro Inferior” of the Salamanca Formation, Punta Peligro locality (Chubut province, Argentina),

which was included in the family Sudamericidae (Scillato-Yané and Pascual 1985). The second one was *Gondwanatherium patagonicum* from the Late Cretaceous Los Alamitos Formation, Los Alamitos locality (Río Negro province, Argentina), included in the family Gondwanatheriidae (Bonaparte 1986b). The first studies on these taxa regarded them as therian mammals (Mones 1987, Bonaparte 1986a, b, 1987, 1988, Bonaparte and Pascual 1987). They were either included among the Paratheria (i.e., a group that formerly included xenarthrans, armadillos, pangolins, taeniodonts, among others; Scillato-Yané and Pascual 1984, 1985), or as part of the Cohort Edentata, Superorder Xenarthra (sloths, anteaters, and cingulates; Mones 1987).

By the same time Bonaparte (1986b) also described a third, enigmatic taxon from the Los Alamitos Formation, based on an isolated brachyodont molariform: *Ferugliotherium windhausenii*. The species was placed in its own family, Ferugliotheriidae (Bonaparte 1986a), referred to the Allotheria, and, with uncertainties, related to the Multituberculata. Later, Bonaparte (1990) named *Vucetichia gracilis* from the same Formation, based on brachyodont teeth with an occlusal pattern similar to that of the hypsodont-toothed *Gondwanatherium*. A few years later Krause (1993, see also Krause *et al.* 1992) regarded *Vucetichia gracilis* as a junior synonym of *Ferugliotherium windhausenii*. By the late 1980s, the relationships of *Gondwanatherium* and *Sudamerica* with xenarthrans were strongly criticized (e.g., Van Valen 1988, Jenkins 1990). After new collections of specimens and new studies, Krause and Bonaparte (1990, 1993, see also Sigogneau-Russell *et al.* 1991, Krause *et al.* 1992, Bonaparte *et al.* 1993) relocated *Gondwanatherium* and *Sudamerica* (both regarded as Sudamericidae) within the non-therian clade Multituberculata. These authors also stressed the multituberculate affinities of *Ferugliotherium* (Ferugliotheriidae; see also Krause *et al.* 1992; Bonaparte 1990). Consequently, Krause and Bonaparte (1993) recognized the Superfamily Gondwanatherioidea to include sudamericids and ferugliotheriids, as part of Allotheria: Multituberculata: ?Plagiaulacoidea. An informal phylogenetic tree was presented by Krause and Bonaparte (1993) with *Ferugliotherium* as the sister taxon of *Gondwanatherium* and *Sudamerica*.

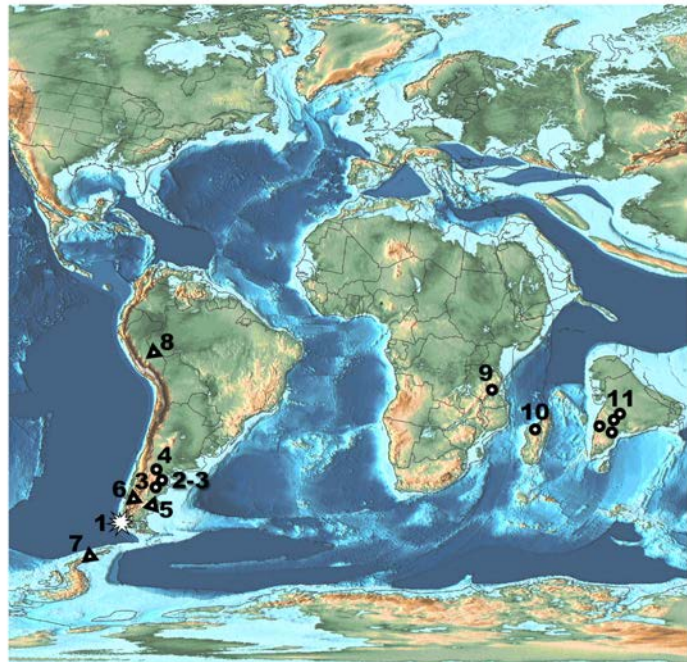
Few years later, Kielan-Jaworowska and Bonaparte (1996) described, from the Los Alamitos Formation, a fragmentary left dentary with the distal wall of the alveolus of a large incisor and a worn plagiaulacoid tooth, regarded by them as a fourth premolar. Due to their provenance and size, they referred the specimen to *Ferugliotherium*. Based on all the evidence, the authors inferred a dentary with one large, rootless incisor separated by a diastema from a plagiaulacoid pm4, and the presence of at least two molars (Kielan-Jaworowska and Bonaparte 1996). This proposal was posteriorly followed by Gurovich and Beck (2009), Rougier *et al.* (2009b), and Krause *et al.* (2020).

The finding of a partial right dentary with dentition (including a large incisor, two mesial molariforms and the loci for two other molariforms distal to them) of *Sudamerica ameghinoi* was pivotal to interpret the morphology and tooth variations of the upper/lower cheek teeth in this species, and the basis to interpret other gondwanatherians (Pascual *et al.* 1999, Koenigswald *et al.* 1999, Gurovich 2008). Based on this specimen and assuming the phylogenetic proximity of ferugliotheriids and sudamericids, Pascual *et al.* (1999; see also Kielan-Jaworowska *et al.* 2004, Pascual and Ortiz-Jaureguizar 2007) predicted that both families didn't have a plagiaulacoid lower premolar but instead four molariform teeth (i.e., cheek teeth), after the enlarged lower incisor. In consequence, the authors claimed that the jaw with a plagiaulacoid tooth from the Los Alamitos Formation was inconsistent with the known lower jaw and dental morphology of *Sudamerica*. However, if that jaw was effectively referable to *Ferugliotherium*, they inferred that sudamericids may have lost this blade-like premolar (Pascual *et al.* 1999). In addition, Pascual *et al.* (1999; see also Kielan-Jaworowska *et al.* 2004; Pascual and Ortiz-Jaureguizar 2007) stated that some of the isolated premolariforms from the Los Alamitos Formation referred by Krause *et al.* (1992) to *Ferugliotherium* could in fact represent actual multituberculates rather than gondwanatherians (as well as the dentary with the plagiaulacoid tooth). On the basis of this hypothesis and on new specimens from the Los Alamitos

and La Colonia formations, Pascual and Ortiz-Jaureguizar (2007) reconstructed the mf1-mf4 series of *Ferugliotherium*. In that reconstruction, the cheek tooth row includes four brachyodont molariforms, with rectangular (mf1-mf2) to quadrangular (mf3-mf4) occlusal surfaces that decrease in size and complexity to the rear (Pascual and Ortiz-Jaureguizar 2007: 96). Subsequent new reports on allotherians from the Cretaceous of South America included the description of *Argentodites coloniensis* (Kielan-Jaworowska *et al.* 2007), from the La Colonia Formation, based on an isolated plagiaulacoid tooth considered as a ?cimolodontan multituberculate (Kielan-Jaworowska *et al.* 2007); and the ferugliotheriid *Trapalcotherium matuastensis* from the Allen Formation, based on a left first molariform tooth (Rougier *et al.* 2009b).

In this swing of discoveries and hypotheses concerning South American Late Cretaceous to Paleocene gondwanatherians, the fossil record of the group was expanded through discoveries in Madagascar (Krause 2013, Krause *et al.* 1997, 2014a, b, c), Tanzania (Krause *et al.* 2003, O'Connor *et al.* 2019), India (Prasad *et al.* 2007, Wilson *et al.* 2007, Verma *et al.* 2012), plus a handful of findings in the Late Eocene of Peru (Campbell *et al.* 2004, Goin *et al.* 2004), Patagonia (Goin *et al.* 2012), and the Antarctic Peninsula (Goin *et al.* 2006). These findings supported the persistence of the group during the Cenozoic as relic Mesozoic lineages (Figure 1). Chimento *et al.* (2015) argued that the middle Eocene *Groeberia minoprioi* and *G. pattersoni*, as well as the Miocene Patagonia peregrina are sudamericid gondwanatherians. However, Zimicz and Goin (2020; see also Beck 2017) supported the metatherian affinities of *Groeberia*, as was historically assumed (e.g., Patterson 1952, Pascual *et al.* 1994). The extremely specialized *Patagonia* was

- GONDWANATHERIA**
- CHILE**  
 1 - *Magallanodon baikashkenke*  
 (Dorotea Fm., Maastrichtian) 
- ARGENTINA**  
 2 - *Gondwanatherium patagonicum*  
 (Alamitos Fm., Campanian-Maastrichtian)  
 3 - *Ferugliotherium windhausenii*  
 (= *Vucetichia gracilis*)  
 (Alamitos Fm. and La Colonia Fm., Campanian-Maastrichtian)  
 4 - *Trapalcotherium matuastensis*  
 (Allen Fm., Campanian-Maastrichtian)  
 5 - *Sudamerica ameghinoides*  
 (Salamanca Fm., Danian)  
 6 - *Greniodon sylvaticus*  
 (Middle Chubut River Volcanic-Pyroclastic Complex, middle Eocene)
- ANTARCTIC PENINSULA**  
 7 - *Sudamericidae* indet.  
 (La Meseta Fm., early-middle Eocene)
- PERU**  
 8 - *Godwanatheria* indet.  
 (Yahuarango Fm., Eocene-Oligocene)
- TANZANIA**  
 9 - *Galulatherium jenkinsi*  
 (Galula Fm., Aptian-Cenomanian)
- MADAGASCAR**  
 10 - *Lavanify miolaka*  
*Vintana sertichi*  
*Adalatherium hui*  
*Sudamericidae* indet.  
 (Maevarano Fm., Maastrichtian)
- INDIA**  
 11 - *Bharattherium bonapartei*  
 (= *Dakshina jederi*)  
*Sudamericidae* indet.  
 (Deccan intertrappean beds, Maastrichtian)



 Cretaceous       Paleogene

**Figure 1.** Global records of gondwanatherian mammals. Late Cretaceous (~80Ma) map (modified from Scotese 2013) including records from Chile, Argentina, Antarctic Peninsula, Peru, Tanzania, Madagascar and India. Main references for each point: 1, this paper; 2, Bonaparte 1986b, Krause and Bonaparte 1993; 3, Bonaparte 1986a, Krause *et al.* 1992, Pascual and Ortiz-Jaureguizar 2007; 4, Rougier *et al.* 2009a; 5, Scillato-Yané and Pascual 1985, Pascual *et al.* 1999, Koenigswald *et al.* 1999, Gurovich 2008; 6, Goin *et al.* 2012; 7, Goin *et al.* 2006; 8, Campbell *et al.* 2004, Goin *et al.* 2004, Antoine *et al.* 2012; 9, O'Connor *et al.* 2019; 10, Krause *et al.* 1997, 2014a, 2020, Krause 2013; 11, Prasad *et al.* 2007, Wilson *et al.* 2007, Verma *et al.* 2012.



originally regarded as a marsupial, within its own Superfamily Patagonioidea (Pascual and Carlini 1987). Posterior reviews (e.g., Goin and Abello 2013, Goin *et al.* 2016) included it within the Polydolopimorphia (Bonapartheriiformes, Argyrolagoidea). *Patagonia* is such an aberrantly derived taxon that a specific test on its affinities is still pending. Remarkable discoveries, in terms of completeness and quality of the studied specimens, are those of *Vintana sertichi* and *Adalatherium hui*, from the Maastrichtian Maevarano Formation of Madagascar (e.g., Krause *et al.* 2014a, b, c, 2020). *Vintana* is represented by a complete skull (lower jaws are missing) and *Adalatherium* by an almost complete, articulated skeleton. Both display a unique mosaic of plesiomorphic and derived features and are key to understand the complex evolutionary history of this group of archaic Gondwanan mammals.

Summarizing, after an initial consideration as therian mammals, gondwanatherians were later referred to the Multituberculata (Krause and Bonaparte 1990, 1993, Gurovich 2006, 2008, Gurovich and Beck 2009, Rougier *et al.* 2009a, b), and later to its sister taxon within allotherians (Krause *et al.* 1997, 2014a, 2019, 2020, Pascual and Ortiz-Jaureguizar 2007, Goin *et al.* 2012). They were also included within Haramiyida (Huttenlocker *et al.* 2018), or regarded as Mammalia *incertae sedis* (Pascual *et al.* 1999, Koenigswald *et al.* 1999, Kielan-Jaworowska *et al.* 2004). More recently, the hypothesis of Gondwanatheria as allotherians allied with (but not belonging to) multituberculates and euharamiyidans, has received much support from new specimens and phylogenetic analyses (e.g., Krause *et al.* 2014a, 2020).

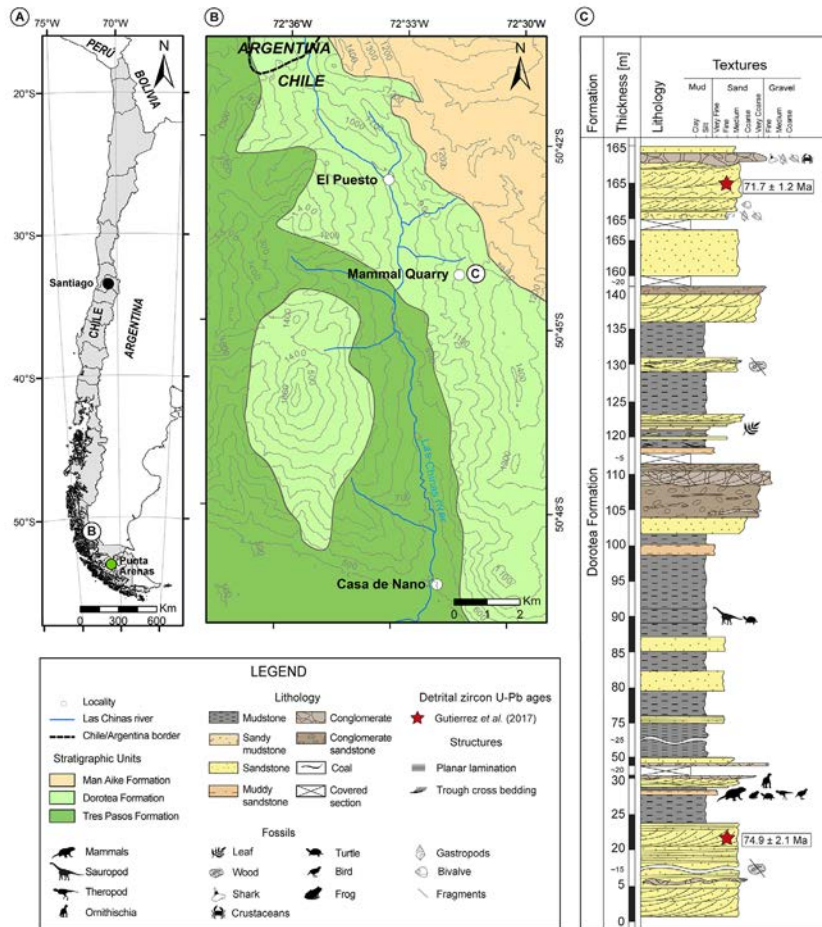
Here we describe a new gondwanatherian mammal from the Late Cretaceous of the Magallanes Region of southern Chile, discovered in the context of a long-term project (starting in 2013) in the Chilean Patagonia by the Chilean Antarctic Institute (Instituto Antártico Chileno) and the University of Chile. The new mammal remains represent the southernmost record of the group for the whole Mesozoic and the first Mesozoic mammal from Chile. The new taxon is based on an upper incisor and three molariforms discovered in a single quarry, namely Mammal Quarry, in the area known as Río de Las Chinas Valley, Estancia Cerro Guido, located about ~100 km north from Puerto Natales City (Última Esperanza Province, Magallanes Region). The mammal-bearing layer is located in late Campanian-early Maastrichtian levels of the Dorotea Formation (Magallanes/Austral Basin). We comment on its affinities, morphological significance, as well as on the biotic and biogeographic context that framed its evolution in southernmost South America.

## GEOLOGICAL AND PALEONTOLOGICAL CONTEXT

The Late Cretaceous units of Última Esperanza Province were deposited over the Magallanes Basin (=Austral Basin), a foreland basin developed and active during the Late Cretaceous-Neogene lapse, forming the internal and external domains of the Southern Patagonian Andes fold and thrust belt system (Biddle *et al.* 1986, Macellari *et al.* 1989, Fildani *et al.* 2008, Romans *et al.* 2011, Cuitiño *et al.* 2019). Three sedimentary units were recognized in the Río de Las Chinas valley. The oldest one is the Tres Pasos Formation (Katz 1963) of Campanian-Early Maastrichtian age (Macellari 1988, Shultz *et al.* 2005, Romans *et al.* 2011). It is conformably overlaid by the Dorotea Formation (Katz 1963) of Late Campanian-Danian age (Gutiérrez *et al.* 2017, George *et al.* 2020). Finally, the youngest Man Aike Formation (Feruglio 1938), of Lutetian-Bartonian age, unconformably overlies the Dorotea Formation in erosive contact (Gutiérrez *et al.* 2017, Schwartz *et al.* 2017, Sickmann *et al.* 2018, Manríquez *et al.* 2019). The mammalian remains described herein were discovered in a fossiliferous level of the Dorotea Formation (Katz 1963) (Figure 2).

The Dorotea Formation represents a marine to transitional succession of rocks (Fosdick *et al.* 2015, Schwartz *et al.* 2016, George *et al.* 2020), cropping out in a N-S direction, along the international border between Chile and Argentina (Sickmann *et al.* 2018) (Figure 2). The Chilean unit is equivalent to La Irene,

Chorrillo, Calafate, and Cerro Cazador formations in the Argentinian side (Nullo *et al.* 2006, Manríquez *et al.* 2019). The depositional environment of the Dorotea Formation has been interpreted as a transitional shallow marine shelf-edge to delta influenced by tides (Covault *et al.* 2009, Hubbard *et al.* 2010, Schwartz and Graham 2015, Manríquez *et al.* 2019, Rivera *et al.* 2020). The Dorotea Formation outcropping in the eastern flank of the Río Las Chinas valley comprises 900 to 1200 m thick fossiliferous deposits of sandstones (greenish-gray and reddish-brown), frequent conglomerate and siltstone lenses, thin beds of sandy calcareous concretions and mudstones (Cecioni 1957, Katz 1963, González *et al.* 2015, Manríquez *et al.* 2019) (Figure 2). Along the succession there are several fossil-bearing levels with abundant pteridophytes, gymnosperms, angiosperms, bivalves, gastropods, ammonites, chondrichthyans, anurans, plesiosaurs, mosasaurs, turtles, dinosaurs, and the mammals described here (Katz 1963, Cortés 1964, Soto-Acuña *et al.* 2014, 2016a, b, Schwartz and Graham 2015, Leppe *et al.* 2016, Manríquez *et al.* 2019, Alarcón *et al.* 2020, Trevisan *et al.* 2020) (Figure 2). The fossil-bearing mammal horizon corresponds to sandy mudstone with fine-grained sandstone lenses (Figure 2), interpreted as floodplain facies associated to a meandering fluvial deposit (Manríquez *et al.* 2019). The presence of numerous bones and teeth of different



**Figure 2.** A, Location map of the Río de Las Chinas Valley, Estancia Cerro Guido, Última Esperanza Province, Magallanes Region, southern Chile. B, Location of the Mammal Quarry. C, Representative stratigraphic profile of the Late Cretaceous Dorotea Formation (Magallanes/Austral Basin), showing the level where the specimens of *Magallanodon baikashkenke* gen. et sp. nov. were found, at ~30m above the base. The stars indicate the levels with absolute radiometric dating.

taxonomic groups in these layers together with the mammal teeth suggests a terrestrial environment with more limited marine influence than other levels, lacking typical marine fauna and traces. The deposits result of the accumulation of silt, clay, and fine sand and then increased accumulation of coarse sand with cross-stratification near to the coastline. The associated taphoflora is inferred from macrofossil compression of stems, sterile and fertile fronds, leaves and a few reproductive structures. The assemblage is dominated by ferns and angiosperms (Trevisan *et al.* 2020), the last ones including large and well-preserved leaves of Lauraceae and Rosaceae. Among pteridophytes, there are fossils belonging to *Equisetum*, *Cladophlebis*, Dicksoniaceae and Cyatheaceae, typical understory of humid forests, but with the record of aquatic forms, such as Marsileaceae ferns, indicating the influence of lacustrine and riparian freshwater environments. Endorsing this interpretation, the finding of monocot imprints of Poales (cf. Typhaceae), complete the scene with aquatic plants, perennial, hydrophytic to helophytic. Horsetails are very frequent indicating the transition among freshwater low-energy environment to land sandy conditions.

U-Pb maximum depositional age above and below the mammal-bearing horizon provides values between  $71.7 \pm 1.2$  Ma and  $74.9 \pm 2.1$  Ma (Gutiérrez *et al.* 2017), respectively, which allow us to refer it to a Late Campanian-Early Maastrichtian age for the fossil-bearing levels. These levels are equivalent to the Chorrillo Formation (Furque and Camacho 1972) exposed at the south of Lago Argentino, Santa Cruz Province, Argentina (Nullo *et al.* 2006), which has also provided a taxonomically diverse and abundant fossil record (Novas *et al.* 2019).

## MATERIAL AND METHODS

Field work and specimen recovery: The holotype and referred specimens herein described were collected by both picking at the outcrop and at the lab after dry- and screen-washing of sediments collected during the 2017 to 2019 field seasons.

Specimens imaging: Scanning electron microscope (SEM) images were made for specimens CPAP 5906 and CPAP 5916. CPAP 5906 was scanned at the Laboratorio de Microscopía Electrónica y Microanálisis of the Facultad de Ciencias Físicas y Matemáticas of the Universidad de Chile, and CPAP 5916 at the Unidad de Microscopía Avanzada of the Pontificia Universidad Católica de Chile, both at Santiago, Chile. For the enamel microstructure imaging, due to the unique nature of the specimen collected (CPAP 5906, an upper right mesial incisor), we opted to polish the distal portion of the specimen; thus, we were able to obtain only transverse views of its enamel. After polishing, the enamel was exposed a few seconds to a 10% HCl solution.

Dental descriptive terminology: We used the dental terminology employed by Krause (2014) for the dentition of *Vintana*. Figure 3 shows a detail of the dental anatomy here employed. The dental formula for gondwanatherians is a problematic issue (e.g., Pascual *et al.* 1999, Krause 2014, Krause *et al.* 2014a) due to the lack of complete dental sequences in most species, and the lack of different ontogenetic stages to evaluate replacement and morphological changes. The lower jaw of *Sudamerica ameghinoides* supports a lower dental formula of one incisor, no canine, and four cheek teeth (Pascual *et al.* 1999). Based on isolated teeth, four upper cheek teeth were inferred for this same taxon (Koenigswald *et al.* 1999, Gurovich 2008). Due to the homology problem, upper and lower cheek teeth of *Sudamerica* were regarded in the literature as “molariforms” (e.g., Koenigswald *et al.* 1999, Gurovich 2008, Gurovich and Beck 2009). The skull of *Vintana* indicates the existence, in the upper dentition, of 2I, 0C, 1PMF, 4MF (Krause 2014, Krause *et al.* 2014a). The skull and jaws of *Adalatherium* indicates 2I/1i, 1C/0c, 5/4 cheek teeth. The first upper cheek tooth was considered a premolariform due to its small size and less complex morphology (Krause *et al.* 2020), similar to the condition of *Vintana*, while the remaining were considered as postcanine teeth. The four

lower cheek teeth of *Adalatherium* show an increased posterior complexity, but the premolar/molar nature for these teeth was not further discussed. Summarizing, available evidence suggests five upper cheek teeth for gondwanatherians, with the first one reduced and premolariform in gross morphology, based on *Vintana* and *Adalatherium*, as well as four lower cheek teeth, based on *Sudamerica* and *Adalatherium*; however, the bizarre morphology of the dentition of *Adalatherium* precludes a clear identification of premolariforms and molariforms.

Dental abbreviations: I, upper incisor; MF/mf, upper/lower molariforms; PMF, upper premolariforms. The numbers indicate the suggested position of each tooth in the series. All measurements are in mm.

Enamel microstructure abbreviations: EDJ, enamel-dentine joint; IPM, interprismatic matrix, OES, outer enamel surface, P, prism; PLEX, prismless enamel.

Institutional Abbreviations: CPAP, Paleontological Collection of Antarctica and Patagonia, Instituto Antártico Chileno, Punta Arenas, Chile. MACN-PV-RN, Colección Río Negro, Sección Paleontología Vertebrados, Museo Argentino de Ciencias Naturales “Bernardino Rivadavia”, Buenos Aires, Argentina.

SYSTEMATIC PALEONTOLOGY  
MAMMALIA Linnaeus 1758  
GONDWANATHERIA Mones 1987  
?FERUGLIOTHERIIDAE Bonaparte 1986a

Genus *Magallanodon* nov.

urn:lsid:zoobank.org:act:06DA7596-509A-4FA8-A5FA-811377C879DBType

Species: *Magallanodon baikashkenke* sp. nov.

Diagnosis: As for the species, by monotypy.

*Magallanodon baikashkenke* sp. nov.

urn:lsid:zoobank.org:act:7A0C2687-9C46-408D-9D90-9AEB475A3583

Derivation of name: The generic name comes from the Magallanes Region in Southern Chile, and *odontos*, Greek for “tooth”. The specific name derives from the Tehuelchian terms *bai* (grandfather) and *kashkenke* (valley). Grandfather’s Valley is the aboriginal name for the current valley of the Río de Las Chinas, where the type locality is placed.

Holotype specimen: CPAP5916, first lower left molariform (mf1; Figs. 3, 4).

Hypodigm: The type and specimens CPAP 5906, an upper right mesial incisor (Figure 5), and the molariforms CPAP 3223 and CPAP 3224, a left and a right ?MF4, respectively (Figure 6).

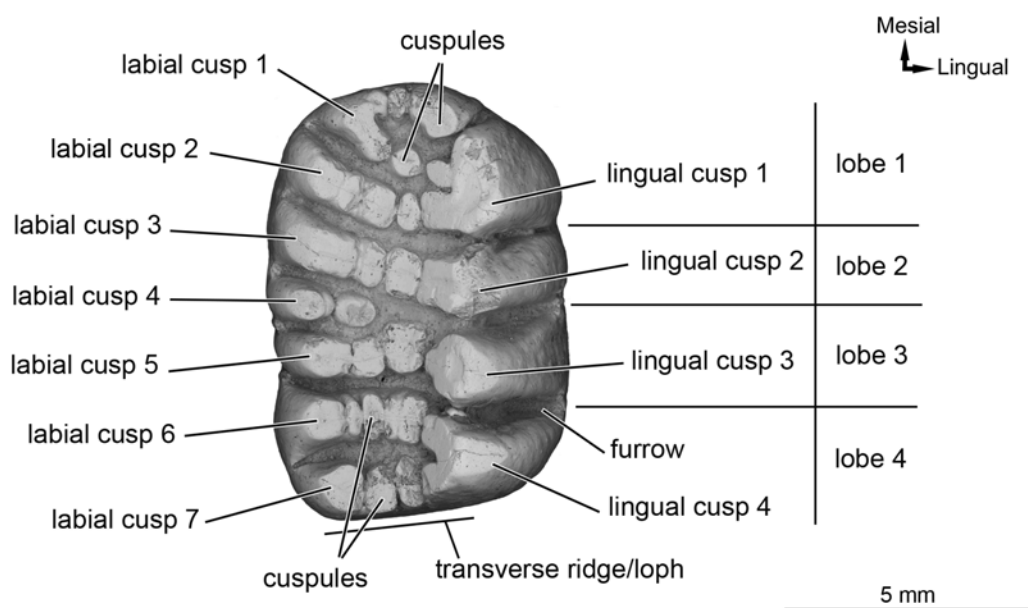
Diagnosis: Large-sized gondwanatherian (mesio-distal length of mf1=8.34 mm; see Table 1) which can be distinguished from other gondwanatherians by the following combination of features: brachyodont molariforms with four to five roots; molariforms with distinct transverse lophs which in unworn condition are formed by multiple rounded adjacent cusps; mesial lower molariform crown with four main lobes, the mesial one D-shaped, the second formed by a longitudinal ridge, and the third and fourth V/U-shaped in occlusal view, all of them separated by continuous labio-lingual grooves that open on the lingual wall



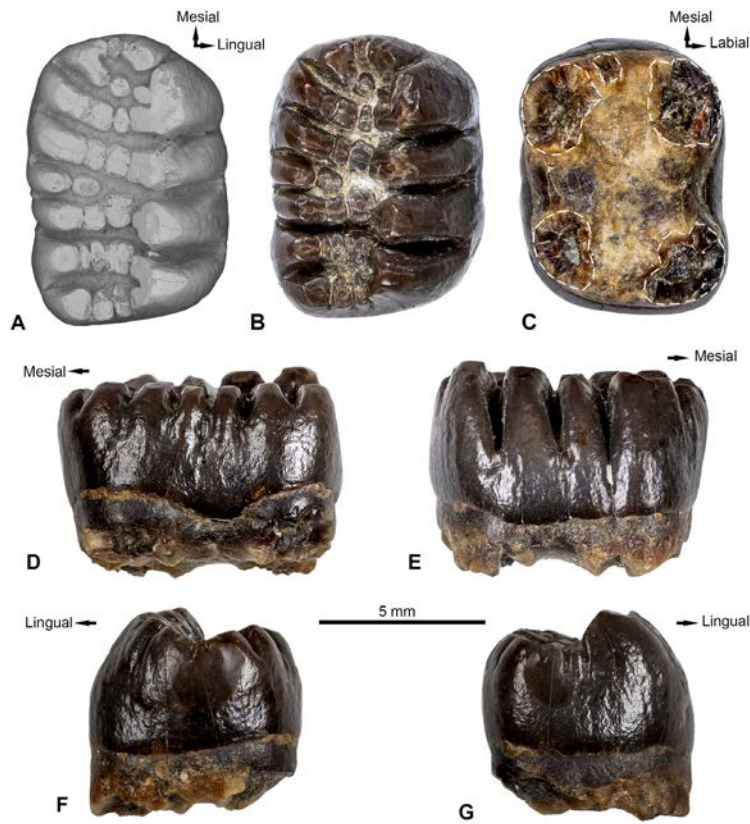
of the crown as deep furrows; the lobes define seven cuspules on the labial margin of the crown of mfl; distalmost upper molariforms with two lobes divided by a transverse groove that starts in the labial edge and does not reach the lingual side; presence of islets on the worn occlusal surface of the lobes; distalmost upper molariforms with crown distal width  $\frac{3}{4}$  smaller than the mesial width.

Comment: *Magallanodon baikashkenke* is tentatively referred to the family Ferugliotheriidae as it shares the same occlusal pattern observable in worn molariforms of ferugliotheriids (e.g., specimens MACN-PV-RN 20 and MACN-PV-RN 174), as well as on its brachyodont condition (Krause and Bonaparte 1993). The remaining gondwanatherians have hypsodont cheek teeth (e.g., Bonaparte 1986b, Krause *et al.* 1997, 2014a, 2020, Pascual *et al.* 1999, Wilson *et al.* 2007, O'Connor *et al.* 2019) or an unique cheek teeth dentition (i.e., *Adalatherium hui*; e.g., lower cheek teeth with four major cusps arranged in a diamond pattern and connected by four perimetric crests, bearing a prominent mesio-labial basin on the two distalmost teeth; Krause *et al.* 2020). If its family referral is confirmed by further studies (e.g., new material under preparation and phylogenetic studies), the new species would represent the largest known ferugliotheriid (around five times larger than *Ferugliotherium* and *Trapalcotherium*).

Locality, horizon and age: The holotype and referred specimens come from a small quarry, named Mammal Quarry, located in the Río de Las Chinas valley (50° 42'S / 72° 32'W), Estancia Cerro Guido, ~100 km north from Puerto Natales, Última Esperanza Province, 12th Region (Magallanes and Chilean Antarctica), Chilean Patagonia (Figure 2); base of the Dorotea Formation, Late Campanian to Early Maastrichtian, Late Cretaceous. (Measurements--See Table1).



**Figure 3.** Dental terminology for the lower molariforms of *Magallanodon baikashkenke* gen. et sp. nov. Specimen CPAP 5916 (holotype), a first lower left molariform (mfl) in occlusal view.



**Figure 4.** *Magallanodon baikashkenke* gen. et sp. nov., holotype specimen CPAP 5916, first lower left molariform. SEM image in occlusal view (A) and photographs in occlusal (B), radicular (C), labial (D), lingual (E), mesial (F), and distal (G) views.

**Table 1:** Measurements of *Magallanodon baikashkenke* gen. et sp. nov.

Number	Specimen	Mesio-distal length (mm)	Labio-lingual width (mm)	Crown height (mm)
CPAP 3223	Left MF4?	6.19	5.05	2.28
CPAP 3224	Right MF4?	6.55	5.13	2.32
CPAP 5906	Upper right incisor	4.40	5.40	13.69
CPAP 5916	Left mfl	8.34	6.31	4.42

## DESCRIPTION

Upper mesial incisor: Specimen CPAP 5906 has preserved its apical portion (Figure 5). The tooth is strongly curved (labially convex, lingually concave) and is subelliptical in section (it is slightly compressed mesio-distally). Its thickness is not homogeneous, as it gets thinner at its apical end (the tip is broken). The cross section is subcircular all along the tooth. One of its lateral faces lacks enamel; we infer that this is the mesial face of the tooth, thus being an upper right mesial incisor. The lingual face has a thin stripe of enamel covering only less than half of this face. Along the incisor extension a series of enamel ribs can be observed on the labial and distal faces, being most prominent on the distal face. Dentine also contributes to the formation of these ribs. The first two ribs are close to each other. A third one is clearly set apart from the former two, while the remaining ribs are aligned at regular intervals.

Comment: The size of specimen CPAP 5906 is clearly compatible with that of the molariforms of *Magallanodon baikashkenke*. This, together with the absence of other mammalian specimens even remotely similar in size to it, led us to confidently assign the specimen to this species. From previous works on much more complete gondwanatherian specimens (e.g., Krause 2014, Krause *et al.* 2014a, 2020) it is clear that the upper mesial incisor is strongly curved (arch-shaped), more than the lower incisor and the upper distal one. Specimen CPAP 5906 displays a curvature similar to that of the upper mesial incisor of the skull of *Vintana* (Krause 2014). This, and the presence of enamel ribs on its labial surface, supports the assignment of this tooth to an upper mesial incisor.

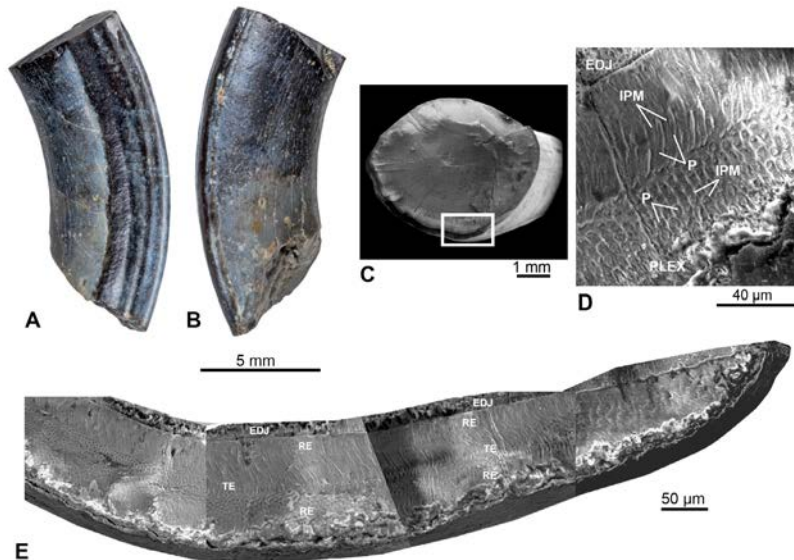
Lower molariform: CPAP 5916 is a left mfl, which was chosen as the holotype specimen (Figure 4). It is a large and relatively elongated tooth, and it barely shows any wear at all. The presence of a low crown, together with a clear cervix and distinctive roots, define a typical brachyodont pattern. The crown is subquadrangular in occlusal view, with the mesial face somewhat rounded and the distal one flat (Figure 4 A, B). It does not show cementum in any of its faces. The mesial face lacks an interdental contact facet, as expected for a first lower cheek tooth (some gondwanatherians lack a tooth anterior to the first lower molariform; e.g., Pascual *et al.* 1999); instead, there is a small facet on the distal face, semilunar in shape, developed at its labial half. The crown base shows a distinct interruption of the enamel layer at the cervix that defines a conspicuous neck. The mesial and distal faces of the tooth are subvertical; the labial face is subvertical in its lower two-thirds, curving gently at the upper third. Finally, the lingual face is not subvertical but instead is inwardly curved. The labial face of the tooth is just slightly higher than the lingual one. There are seven distinct cusps in the labial face of the crown, separated by small valleys that descend just a fifth of the crown height. In turn, on the lingual face of the crown there are four main cusps that are larger than the labial cusps. The main lingual cusps have a strongly convex lingual wall and a labial flat surface, where most of the wear is initially produced. The main lingual cusps are split by deep furrows that run down more than half of the crown height. These deep lingual furrows and their transverse grooves that continue over the crown to the labial side define four lobes (Figs. 3, 4 A-B).

In occlusal view, the four lobes are separated by transverse grooves, which on the lingual wall are deeper than in the labial face. The first lobe (mesial) is externally outlined as D-shaped. It has three slightly oblique ridges: the mesial ridge has two cuspules, the central ridge has two central cuspules and a crest-like cusp, which corresponds to the first labial cusp, and the distal ridge has at least two middle cuspules and the second labial cusp. The second lobe is formed only by a transversal ridge with the main second lingual cusp, two central cuspules and the third labial cusp. The third lobe is V-shaped, with three central cuspules and the fourth and fifth labial cusp. The fourth lobe is U-shaped; the mesial ridge has at least four central

cusps and the sixth labial cusp, while the distal ridge has two central cusps (lying on the distal wall of the crown) and the seventh (last) lingual cusp (Figure 4 A). The unworn nature of CPAP 5917 clearly demonstrates how the transverse ridges (lophs) are formed by tiny, aligned cusps.

The two distal lingual cusps, as well as (at least) the last three labial cusps of CPAP 5916 show on their worn surfaces a series of striations that run roughly parallel to the dental axis, although slightly oblique to it, in a mesio-lingual to disto-labial direction. These striations are indicative of the masticatory movements of *Magallanodon*, which in turn are congruent with the inferred palinal movements of other gondwanatherians (e.g., Krause and Bonaparte 1993). The tooth has four subequal roots of relatively large size, as well as a tiny, fifth one near the mesial face; all roots are broken at their bases (Figure 4 C). The four large roots are placed at each corner of the tooth: mesio-labial, mesio-lingual, disto-labial, and disto-lingual.

Comment: We refer the holotype CPAP 5916 as a first lower left molariform following comparisons with other gondwanatherians. First, it is similar in shape and proportions to other lower molariforms referred to mf1 as for example for *Ferugliotherium*, *Trapalcotherium*, and *Gondwanatherium* (e.g., Krause *et al.* 1992, Gurovich 2006, Rougier *et al.* 2009a). Second, the first molariform is the longest of the upper and lower series in *Sudamerica* (Koenigswald *et al.* 1999: table 1, Pascual *et al.* 1999). Taking in account the differences in size with the specimens here referred to ?MF4 (the holotype is quite mesio-distally longer; see Table 1), it is reasonable to assume that it corresponds to a mf1. Third, as it happens in several caviomorph rodents, it is quite possible that in gondwanatherians an inverse relation of furrows in the upper and lower molariforms occurs, opening labially in the upper ones (Krause 2014, Krause *et al.* 2014a) and lingually in the lower ones. Fourth, the mesial wall of the crown lacks an interdental contact facet, as expected for a first lower cheek tooth, as in other gondwanatherians (e.g., Pascual *et al.* 1999), and the distal wall bears this facet, indicating a subsequent tooth. For this reason we infer that the holotype of *Magallanodon* is a left mf1 (Figures 3, 4).



**Figure 5.** *Magallanodon baikashkenke* gen. et sp. nov. Specimen CPAP 5906, an upper right mesial incisor, in distal (A) and mesial (B) views. C, SEM image of the transverse section of the tip of the incisor showing the analyzed region of the enamel layer. D, SEM image of the distal end of the enamel band showing the different types of enamel. E, SEM image with detail of the enamel layer showing the path of the prisms. Abbreviations: EDJ, enamel-dentin junction; IPM, interprismatic matrix; P, prism; PLEX, prismless enamel; RE, radial enamel; TE, tangential enamel.



?Upper molariforms: Specimens CPAP 3223 and CPAP 3224 are tentatively referred to last upper molariforms (MF4; see below); the former, a left one, and the latter, a right one (Figure 6). In occlusal view, CPAP 3223 is subrectangular in shape, wider than long; with the height of the crown about half the mesio-distal length of the tooth. It has a well-defined neck between the crown and the roots. Four roots are observable: two labial and two lingual. The occlusal surface is not flat, as the lingual third is higher than the central and labial parts, gently sloping towards them. The mesial face of the tooth shows a wide interdental facet, while the distal face does not (as expected in a last MF). The mesial half of the crown is wider than the distal half. A deep syncline (transverse groove) runs from the labial face almost reaching the lingual edge of the tooth, and divides the tooth in two lobes. This syncline is not straight but instead is mesially directed in its first third (from the labial face) to almost transverse in its remaining length. The syncline ends in a deep furrow directed posteriorly at the labial face. Anterior to the syncline there is a mesio-distally compressed islet, and posterior to it there are two islets, also mesio-distally compressed. Both islets are surrounded by enamel (Figure 6A, B).

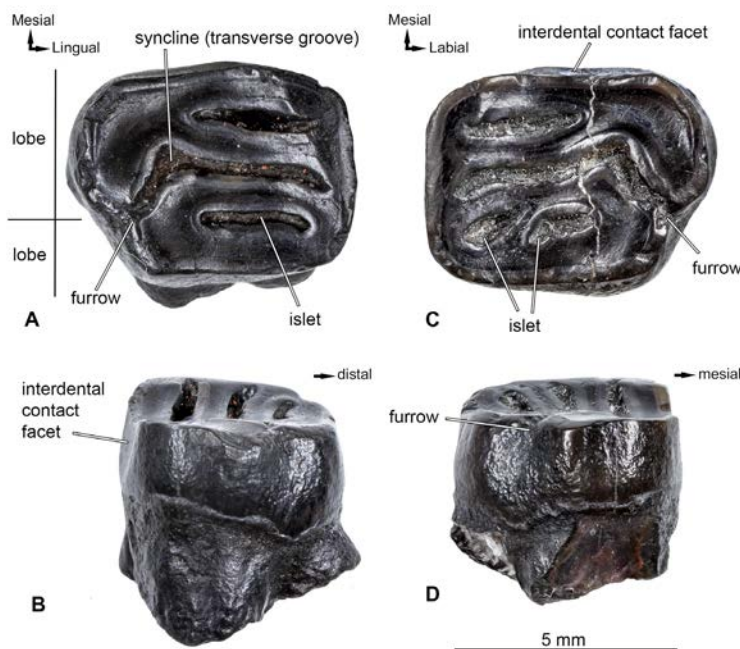
Specimen CPAP 3224 is very similar in morphology and dimensions but opposite in shape to CPAP 3223. We interpreted it as a slightly more worn right ?MF4 (Figure 6). It has an interdental wear facet at the mesial face, lacking one at the distal face. Probably due to its more intensive wear, distal to the syncline there are two (Figure 6 C) instead of a single larger islet surrounded by enamel, as occurs in CPAP 3223 (Figure 6 A).

Comments: There are several interesting resemblances when comparing specimens CPAP 3223 and CPAP 3224 to the last upper molariform of *Vintana sertichi* (see Krause 2014, Krause *et al.* 2014a): (1) molariform proportions, with the distal half narrower than the mesial one; (2) a deep furrow oriented backwards on the labial face; (3) a central syncline dividing the molariform in halves (however, the MF4 of *Vintana* has two furrows, while *Magallanodon* shows only one). Also, only one transverse groove with a labial furrow, which defines two lobes is a feature similar to the condition inferred in the distal molariforms of ferugliotheriids (e.g., Krause and Bonaparte 1993). Additionally, the presence of only one interdental wear facet indicates that the molariform locus is at an extreme end of the series (i.e., either a MF1 or a MF4). Taking in account all these aspects, we provisionally refer both molariforms (CPAP 3223 and CPAP 3224) to MF4.

Besides their obvious differences in crown height, there are remarkable similarities between the specimens CPAP 3223 and CPAP 3224 of *Magallanodon* and MACN-PV-RN 1025 of *Gondwanatherium patagonicum*, regarded by Gurovich (2006) as a lower left molariform. Even though, as it happens in *Vintana*, *Gondwanatherium* has two labial furrows instead of a single one, the overall proportions of the molariform, as well as the lophs, syncline and islet morphology, are suggestive of a similar locus in the upper molar series. Thus, we provisionally refer MACN-PV-RN 1025 of *Gondwanatherium* to a ?MF4. We also wonder if specimen MACN-PV-RN 20 of *Ferugliotherium*, regarded by Krause *et al.* (1992) as a second (and last) lower molar, actually constitutes a last upper molariform, as its morphology and overall proportions closely match those of specimens CPAP 3223 and CPAP 3224.

#### ENAMEL MICROSTRUCTURE

Description: In cross section, the enamel layer of the upper incisor (CPAP 5906) reaches 160 microns in the thickest portion, which is very thick compared to other gondwanatherians (e.g., Koenigswald *et al.* 1999, Koenigswald and Krause 2014). Three enamel zones can be distinguished, two of radial enamel and one of tangential enamel between them (Figure 5). Towards the distal end of the enamel, the tangential enamel occupies the entire thickness of the band. The orientation of the tangential enamel prisms shows a



**Figure 6.** *Magallanodon baikashkenke* gen. et sp. nov., left upper molariform (?MF4) CPAP 3223 (A, B) and right upper molariform (?MF4) CPAP 3224 (C, D), in occlusal (A, C) and labial (B, D) views.

lateral inclination on the distal side. Unfortunately, there is a single photographic record of the enamel band on the distal side, which does not allow the recognition of a neutral zone (see, e.g., Koenigswald *et al.* 1999), nor the mesial portion of the enamel. A neutral band is observable in sudamericids, such as *Sudamerica* (Koenigswald *et al.* 1999). Enamel microstructure is unknown for the incisors of *Ferugliotherium* or *Trapalcotherium*.

In the innermost zone of the enamel layer the upward inclination of the prisms regarding the dental axis is very slight, but in the next zone the prisms change direction in a simultaneous prism deviation, to finally rise abruptly towards the occlusal surface (Figure 5). Prisms are small, of 4 to 5 microns in diameter, and some have incomplete prism sheaths. They are surrounded by a thick interprismatic matrix (IPM) whose crystals are arranged at an angle of 45° with respect to the prisms, at the level of the tangential enamel. The prisms are organized into ordered and aligned rows, as is evident in the outermost radial enamel area. However, the IPM does not form interrow sheets but instead is anastomosed. No decussation of prisms was observed. In the outermost portion of the enamel, a thin area (around 15 µm) is recognized, in which the prisms lose definition (fade away) until they disappear so that the IPM becomes dominant towards the outer enamel surface (OES).

**Comparisons:** The composition in terms of enamel types of the gondwanatherian incisors show significant variations between the distal and mesial sides of the enamel band, unlike other groups of mammals (e.g., rodents) where this does not occur. In gondwanatherians, the incisor *schmelzmuster* is made by a combination of radial and tangential enamel; in the latter, prisms are oriented in opposite directions between the distal and the mesial sides. Normally, between both fields of tangential enamel there is a “neutral area” of radial enamel. Contrary to what was observed in *Magallanodon*, the incisor enamel of *Sudamerica ameghinoi* has an inner layer of radial enamel, one of tangential enamel and a thick outer

layer of PLEX (Koenigswald *et al.* 1999). The prisms are separated by incomplete prism sheaths from an unusually thick IPM. A neutral area of somewhat mesial position separates the two tangential enamel fields in which its opposite-oriented prisms converge towards it. Towards the distal end of the enamel, the enamel band thins, being only formed by radial enamel. Goin *et al.* (2006) studied the enamel of a gondwanatherian incisor from the Middle Eocene of Antarctica, tentatively referred to as cf. *Sudamerica ameghinoi*. Its enamel microstructure differs in part from that of *Magallanodon* in that the *schmelzmuster* is made up of two layers of tangential enamel, divided into two fields, one mesial and one distal, by a neutral area which is similar to that observed in *Sudamerica* (close to the mesial inflection of the enamel band). The authors were able to observe that the prisms of the inner layer of tangential enamel diverge from the neutral area while the prisms of the outer layer of tangential enamel converge towards the neutral area (coincident with the outer tangential enamel layer of *Sudamerica*). As in *Sudamerica*, in the Antarctic specimen the prisms are surrounded by a thick layer of IPM and have incomplete prism sheaths.

The enamel of *Gondwanatherium patagonicum* shows several features similar to those of *Magallanodon*. *Gondwanatherium* shows a neutral area of radial enamel much more extensive than in *Sudamerica*, which is located on the distal side (Koenigswald *et al.* 1999). In both fields the tangential enamel is seen as a central layer of increasing thickness towards the distal end of the enamel, between two layers of radial enamel. The tangential enamel prisms show opposite directions in both fields, diverging from the neutral area and opposite to that observed in *Sudamerica*. In *Magallanodon*, the pattern coincides with this three-layer pattern, with the tangential enamel prisms tilted laterally towards the distal side. Unfortunately, the complete enamel band of the later was not available; therefore, the “neutral area” and the inclination of the tangential enamel prisms in the mesial field could not be identified. In *Gondwanatherium patagonicum*, the enamel layer thins towards the end of the enamel, being made only of tangential enamel; the same is observed in the most distal lip of the enamel of *Magallanodon*. These similarities suggest a common pattern between ferugliotheriids, if *Magallanodon* is effectively a ferugliotheriid, and other gondwanatherians. As previously mentioned, no enamel microstructure analysis has been performed in *Ferugliotherium*’s incisor (also, no incisors are known for *Trapalcotherium*).

## DISCUSSION

*Magallanodon baikashkenke* represents the first Mesozoic mammal for Chile and the southernmost record of a Mesozoic gondwanatherian (the paleolatitude of the Las Chinas valley was ~54° South, van Hinsbergen *et al.* 2015; see Figure 1). The integration of geological and geophysical data, together with tectonic frameworks from well-studied once-conjugate continents have improved the knowledge of the paleogeography of the southern part of the South America/West Antarctica area prior to the break-up of these blocks (Jordan *et al.* 2020). The plate tectonic reconstruction map by the Late Cretaceous (Late Campanian, ~80 Ma; Jordan *et al.* 2020) shows one of the West Antarctica blocks, Antarctic Peninsula (AP) was very near the current Magallanes Region. The *Magallanodon*-bearing horizon of the Dorotea Formation at Río de Las Chinas valley constricted on ~75 Ma probably represents a terrestrial paleoenvironment similar to that depicted for the Late Campanian-Early Maastrichtian of the James Ross Basin (Vega Island, Cape Lamb Member, Snow Hill Island Formation; Reguero *et al.* 2013). Consequently, the presence of gondwanatherians is expected at even more southern latitudes than reported here. Antarctic gondwanatherians are known for the Eocene (Goin *et al.* 2012), so early arrival at this region is expected and supports this biogeographic scenario.

The age of *Magallanodon* is constrained as Late Campanian-Early Maastrichtian, similar to the inferred age of Los Alamitos and Allen formations of northern Patagonia (Río Negro Province, Argentina), where a diverse mammal assemblage was recovered, including gondwanatherians and dryolestoids

(e.g., Bonaparte 1986a, b, 1987, 1990, Pascual *et al.* 2000; Rougier *et al.* 2009a, 2011b). Amongst the mammalian assemblage of Los Alamitos Formation there are two gondwanatherians, the relatively large-sized and hypsodont toothed *Gondwanatherium patagonicum* (Sudamericidae) and the small-sized brachyodont toothed *Ferugliotherium windhausenii* (Ferugliotheriidae) (Bonaparte 1986a, b, Krause *et al.* 1992, Gurovich 2008). In the Allen Formation, there is only one taxon, *Trapalcotherium matuastensis* (Rougier *et al.* 2009a), with a roughly similar size and gross dental morphology to that of *Ferugliotherium*. La Colonia Formation (Chubut Province) has also provided Cretaceous mammals (e.g., Pascual *et al.* 2000, Rougier *et al.* 2009b, Harper *et al.* 2019), including a preliminary report of *Ferugliotherium* (Pascual and Ortiz-Jaureguizar 2007). Nonetheless, the faunal assemblage of this unit was considered as younger than that of Los Alamitos and Allen formations (e.g., Martinelli and Forasiepi 2004, Pascual *et al.* 2000, Rougier *et al.* 2011b). A large sized brachyodont-toothed gondwanatherian taxon like *Magallanodon* is yet unknown in these Cretaceous assemblages of northern Patagonia. As a consequence, considering a roughly similar age between the Dorotea Formation and the Los Alamitos/Allen formations, the presence of *Magallanodon* in high southern latitudes likely highlights distinctive ecological strategies for Late Cretaceous gondwanatherians, including large sized/brachyodont toothed forms, small-sized/brachyodont toothed forms, and large-sized/hypsodont toothed forms. Similarly, they all share enlarged, rodentiform incisors. Further studies on the whole faunal and floral associations of these units will elucidate the diverse ecologic dynamic by the Late Cretaceous, which resulted in taxonomically diverse and morphologically disparate non-therian mammal morphotypes.

Is *Magallanodon* a ferugliotheriid gondwanatherian?--*Magallanodon baikashkenke* is a Late Cretaceous mammal, that can be confidently referred to Gondwanatheria. Within this clade, it shares more features with ferugliotheriids than other gondwanatherians (e.g., sudamericids, adalatheriids). As a consequence, it is tentatively referred to the Ferugliotheriidae until new material and studies are provided. The preserved remains are consistent with it being a gondwanatherian: hyperthrioped, rodent-like first upper incisor, molariform teeth with transverse ridges (lophs) and furrows (labial in MFs, lingual in mfs), and evidences of palinal masticatory movements (e.g., striations made by wear in the molariform cusps, which are more or less aligned with the dental row). Our referral of *Magallanodon*, with doubts, to the ?Ferugliotheriidae (see a revised diagnosis in Krause and Bonaparte 1993) is supported by a molariform occlusal pattern that is similar to that of *Ferugliotherium* (e.g., specimens MACN-PV-RN 20, MACN-PV-RN 174) in conjunction with brachyodont crowns supported by transverse pairs of roots (in the case of the holotype, there are two pairs of large, transverse roots and a minute, additional one at the mesial edge of the crown; Figure 4 C). The only feature that disagrees with Krause and Bonaparte's (1993) diagnosis of Ferugliotheriidae is its size, as members of this family were regarded as small compared to the Sudamericidae. *Magallanodon* is comparable in size to the largest members of this last family.

With the exception of *Adalatherium*, which exhibits extremely bizarre cheek teeth dentition (Krause *et al.* 2020), all other non-ferugliotheriid gondwanatherians (sudamericids plus gondwanatherians of uncertain affinities, such as enamel-less toothed *Galulatherium*; O'Connor *et al.* 2019) show some degree of hypsodony (e.g., Bonaparte 1986b, Krause *et al.* 1997, 2014a, b, Pascual *et al.* 1999, Krause 2003, 2014, Wilson *et al.* 2007, Goin *et al.* 2012). In this regard, *Magallanodon* presents a brachyodont pattern with crowns that functionally work as those of sudamericids, including a system of lobes, with transverse lophs separated by furrows, palinal jaw movements during chewing, and distinctive dental roots. This also characterized the already known brachyodont ferugliotheriids (e.g., Krause and Bonaparte 1993). *Vintana sertichi*, from the Late Cretaceous of Madagascar, was considered to have hypsodont cheek teeth (Krause 2014, Krause *et al.* 2014a), however, we think that this is debatable: its molariforms have several roots, a distinctive crown/root division, and relatively low crowns (although they are strongly worn). As no other specimens of *Vintana* are known, the precise height of its unworn molariforms cannot be assessed. We suggest that a brachyodont to mesodont condition could better define their crown pattern.



Further studies and new specimens are certainly essential to improve the understanding of morphological variation and homologies along the tooth rows in poorly known gondwanatherian species, which in the last years have produced disparate opinions, especially regarding ferugliotheriids (e.g., Pascual *et al.* 1999, Kielan-Jaworowska *et al.* 2004, Pascual and Ortiz-Jaureguizar 2007, Gurovich 2008, Gurovich and Beck 2009, Rougier *et al.* 2009b, Krause 2014, Krause *et al.* 2014a). Better knowledge of these species will support or refute the taxonomic and phylogenetic hypotheses for the members of this specialized group of non-therian mammals. With the available evidence on the clade and the set of features known in *Magallanodon*, we opt to consider it as tentatively allied to the Ferugliotheriidae.

Significance of the molariform pattern of *Magallanodon*--One of the most outstanding aspects of the molariform morphology of *Magallanodon baikashkenke* is that it sheds light on how the transverse lophs (ridges) of gondwanatherians did evolve: not as crests joining opposite cusps but instead by a series of minute, labial-lingual aligned cuspules that developed between major opposite cusps (Figures 3, 4). This feature was partially evident in *Ferugliotherium* (Krause *et al.* 1992, Krause and Bonaparte 1993) and some sudamericid gondwanatherians, such as *Gondwanatherium* (Bonaparte 1986b, 1988, Gurovich 2008). Specimen MACN-PV-RN 22 of *Gondwanatherium*, for example, shows at least three small cusps which are aligned forming the lingual half of the second ridge. However, due to the worn nature of most collected sudamericids, this feature is not observable in most of the known specimens. The holotype of *Magallanodon baikashkenke* indicates that all lophs/ridges developed following the same pattern.

Another relevant aspect that deserves further comment is the strong degree of wear seen in the molariforms of *Magallanodon*, as revealed by specimens CPAP 3223 and CPAP 3224, which is unusual in a brachyodont mammal. It seems clear the ecological context must have favored the development of hypsodonty among gondwanatherians, as revealed by the relatively high diversity of hypsodont toothed sudamericid taxa from the Late Cretaceous. Both the molar morphology and the inferred masticatory movements of gondwanatherians are suggestive of herbivorous feeding habits that probably included hard plant materials, as those inferred for *Vintana sertichi* (Schultz *et al.* 2014), including roots, seeds, twigs, and/or nut-like fruits.

## CONCLUSION

We describe the first Mesozoic mammal for Chile, discovered in the Upper Cretaceous Dorotea Formation (Magallanes/Austral Basin) at the Río de Las Chinas Valley, Estancia Cerro Guido, Última Esperanza Province, Magallanes Region, southern Chile. It is based on isolated teeth (one incisor and three molariforms) that represent a new genus and species, *Magallanodon baikashkenke*, included into the allotherian clade Gondwanatheria. Based on its gross occlusal morphology and brachyodont molariforms it is tentatively referred to ?Ferugliotheriidae, which at the moment was endemic for northern Patagonia, Argentina. The relatively large size of this species coupled with its large, hypsodont incisors and brachyodont molariforms highlight the ecological disparity of this group during the Late Cretaceous. This new gondwanatherian record also represents the southernmost for the Cretaceous, but the occurrence of members of this clade in the Antarctic Peninsula during the middle to late Eocene, supports a long-lasting presence in southern latitudes since at least the near end of the Mesozoic.

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